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The progenies of the brachytic-adherent-ramose hybrid furnish evidence that the ramose character may belong to the same linkage series, though the linkage is rather loose.

Although the tassels of ramose plants are much larger than those of normal plants and it seemed not unreasonable to expect adherent-ramose tassels to present a large thickened mass, nothing of the sort was found and the ramose-adherent plants could be separated from the normal-adherent plants only by examining the ears.

White and colored seeds were planted separately, but the percentage of the three characters are essentially alike, as is shown by the following figures indicating that all three are independent of one of the aleurone factors:

	% Adherent	% Ramose	% Brachytic
White seeds planted	16.4 ± 1.65	24.3 ± 1.92	31.5 ± 2.04
Colored seeds planted	18.3 ± 1.00	21.1 ± 1.07	27.9 ± 1.17
Difference	1.9 ± 1.93	3.2 ± 2.2	3.6 ± 2.34

J. H. KEMPTON

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

A GENE FOR THE EXTENSION OF BLACK PIGMENT IN DOMESTIC FOWLS[1]

THE results of recent experiments on the inheritance of plumage colors in fowls indicate that varieties in which black pigment extends to all or nearly all of the plumage (*e.g.*, self black) differ by one dominant autosomal gene from varieties in which black pigment is restricted to the hackle, flight and tail feathers (*e.g.*, Columbian and buff varieties). This gene has been called "extension of melanic pigment" and has been assigned the symbol E^m.

The evidence is derived from reciprocal crosses between Black Orpington and Columbian pattern (Light Brahma) fowls. Whichever way the cross is made the F_1 chicks are all black in the down. As adults, the males from the reciprocal crosses are alike. They are black with white-bordered hackles and saddle feathers; white-bordered and splashed or stippled wing coverts and narrow white borders on the upper breast feathers. They resemble fairly typical Dark Brahma or Duckwing males.

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[1] Contributions in Poultry Genetics, Storrs Agr. Experiment Station.

The females from the reciprocal crosses are unlike in adult plumage. From the cross of Black male by Columbian female, the daughters are self black. From the cross of Columbian male by Black female, the daughters are black with white borders on the feathers of head, hackle, and upper breast. They resemble the pattern known as Birchen.

When backcrossed with Columbian females, the F_1 males have produced black, Columbian and *buff* chicks in the ratio of 4: 3: 1; or approximately equal numbers of chicks with extended and restricted black pigment. When crossed with buff females the same F_1 males have produced chicks in approximately the ratio 2 black: 1 Columbian: 1 buff; again showing equality between the extended and restricted classes. The F_1 black females crossed with buff males have produced equal numbers of black and buff chicks, while the F_1 Birchen females have produced, when crossed with buff males, black, Columbian and buff chicks in a ratio approximating 2: 1: 1. The ratios as quoted above have all been obtained and will be reported in full when the adult classifications have been completed. All of these crosses represent matings of fowls heterozygous in extension ($E^m e^m$) with fowls recessive in extension ($e^m e^m$). The expectation is equal numbers of black (extended) and non-black (restricted) chicks. The experimental numbers at present are 99 black (E^m) : 98 non-black (Columbian or buff e^m). A clear monohybrid segregation is evident between extension (E^m) and restriction (e^m) of black pigment.

The above results are all explained on the following hypotheses:

1. The black fowls have the dominant allelomorph of an autosomal gene (E^m) which determines the extension of black pigment to all parts of the plumage. The recessive allelomorph (e^m) of this gene is present in the Columbian and buff fowls.

2. The black fowls contain the recessive allelomorph of the dominant sex-linked gene S (silver). This dominant gene inhibits the production of buff ground color and causes the production of silver or white ground color;[1,2] it is known to be present in Columbian fowls, while the recessive allelomorph characterizes the buffs. As regards these two genes the blacks used in these experiments have proved to be $E^m E^m ss$ in composition, the Columbians $e^m e^m SS$ (male) or $e^m e^m S$-(female), and the

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[1] Sturtevant, A. H., 1912, *Jour. Exp. Zool.*, 12: 499–518.

[2] Dunn, L. C., 1922, AMER. NAT., 56: 242–255.

buffs e^me^mss. Blacks are therefore genetically buffs with an epistatic gene for the complete extension of black pigment.

3. Extension of black is incompletely epistatic over silver so that in fowls of the genotype E^me^mSs (male) or E^me^mS-(female) silver appears in certain parts of the plumage, producing a pattern like that of the Dark Brahma.

Collateral evidence indicates that the gene for extension of black pigment (or one with similar effects) is present in Barred Plymouth Rocks and White Plymouth Rocks (as a cryptomere); and that it is absent in Columbian and buff varieties and in Rhode Island Reds.

Hurst[3] was probably dealing with the same gene in his crosses between Black Hamburgs and Buff Cochins, since F_1 from this cross consisted of all black chicks, while in F_2 black and buff chicks occurred in the proportions of 88 black: 31 buff. In interpreting the results of this cross Morgan[4] states that either one or two pairs of factors may be involved; which is right "could only be determined by an F_2 ratio." Yet the F_2 ratio is given by Hurst (p. 138) and is surely a sufficiently close approach to a monohybrid ratio. The ratios obtained in our experiments agree throughout with a mono-factorial interpretation.

It is believed that this gene will be found to characterize many color varieties of fowls in which black, either as a self color or as a component of a pattern extends to all or nearly all of the plumage. Concerning its origin no direct evidence can be offered at present. Its occurrence as a discrete unit indicates, however, that its origin was discontinuous and that black varieties probably had their genesis in mutation rather than in selection of particolored types toward black.

L. C. DUNN

THE EFFECTS OF SO-CALLED CONJUGATION IN SHELLED RHIZOPODS[1]

THE phenomenon of conjugation in the Protozoa is regarded as the forerunner of sexual reproduction in the higher animals,

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[3] Hurst, C. C., 1905, Reports to the Evo. Comm., II, pp. 138–39.

[4] Morgan, T. H., 1919, Publ. Carnegie Inst. No. 285, p. 24.

[1] The experimental work on this problem was carried on in the Zoological Laboratory of the Johns Hopkins University. I wish to thank Dr. H. S. Jennings, of that institution, for suggesting the problem and for his aid in pursuing the investigations.